Acropora Corals in Florida: Status, Trends, Conservation, and Prospects for Recovery

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ABSTRACT

Despite representing the northern extent of *Acropora* spp. range in the Caribbean, most of the Florida reef line from Palm Beach through the Keys was built by these species. Climatic factors appear to have been important agents of *Acropora* loss within historic (century) time frames. In the recent past (1980-present), available quantitative evidence suggests dramatic declines occurred in *A. cervicornis* first (late 70's to 84) with collapse of *A. palmata* occurring later (1981-86). However, recent monitoring studies (1996-2001) show continued decline of remnant populations of *A. palmata*. Current trends in *A. cervicornis* in the Florida Keys are hard to assess given its exceedingly low abundance, except in Broward County, FL where recently discovered *A. cervicornis* thickets are thriving. While the State of Florida recognizes *A. palmata* and *A. cervicornis* as endangered species (Deyrup and Franz 1994), this designation carries no management implications. The current management plan of the FKNMS provides many strategies for coral conservation, among them minimizing the threat of vessel groundings and anchor damage, and prohibitions on collection, touching, and damage from fishery and recreational users. Although *Acropora* spp. are not explicitly given any special consideration, they are implicitly by Sanctuary management. Restoration approaches undertaken in the Florida Keys include rescue of fragments damaged by groundings and experimental work to culture broadcast-spawned larvae to re-seed natural substrates. Neither of these efforts have yet realized full success.

Geological history

Prior to the most recent moderate sea-level phase, Florida reef development proceeded under high sea-level conditions in the absence of the sensitive *Acropora* spp. These species were absent in Florida due to the inimical effects of Gulf waters flowing unimpeded from the shelf (now Florida Bay) over the reef tract. Slow-growing head corals built the Pleistocene Florida reefs. However, the spur-and-groove reef structures which we observe in the Florida Keys today as well as for the three-reef system from Palm Beach to northern Miami-Dade County are all constructions of *Acropora palmata* (Lighty 1977, Shinn 1988). The rapid growth of this species has allowed this impressive accretion on a short geological time frame, the last 6-7K years when sea level has been low. Early Holocene conditions were perhaps best conducive to rapid Acroporid colonization, but rising sea levels between 5 and 3 thousand years ago led to the demise of the reef system north of Fowey Rocks, and the die-off of Acroporid reef flats due to flooding and formation of Florida Bay.

Thus, although geological evidence suggests that coral reef formation has occurred in the absence of *Acropora* spp. in the distant past under high sea-level conditions, it is clear that future functional absence of these species will severely compromise the ability of Florida reefs to survive anticipated sea level rise (i.e., their ability to "keep up") in the not-too-distant future.

Long-term trends (100 yr)

The best observational/anecdotal evidence comes from the Dry Tortugas region (Agassiz 1882, Mayer 1902, Davis 1982, Jaap et al. 1989, Jaap and Sargent 1993, etc.). These observations suggest impressive

decline of *A. palmata* occurred between 1881 and 1977 (prior to 1980's white-band disease epidemic) due to natural disturbances such as cold fronts, hurricanes, and "black water" events. Jaap and Sargent (1993) report overall loss of *A. palmata* cover in the Dry Tortugas from 44 hectares in 1881 (Agassiz 1882) to a low of ~200m^2 in 1977 to an area of 1400 m^2 by 1993. Less information is available regarding historical status of *A. cervicornis* in the Dry Tortugas, but it was al so significantly impacted by a severe cold front during the winter of 1976-77. Following the cold front, Davis (1982) reported ~91% loss of staghorn coral in Dry Tortugas. Jaap and Sargent (1993) suggest that disturbances in the Tortugas region (e.g. adverse water quality, possibly destructive storms) have rendered most habitats unsuitable for *Acropora* spp. and hence, makes full-scale recovery unlikely. However, comparisons between maps developed by Agassiz (1882) and those of Davis (1982) illustrated that staghorn coral occupied extensive areas of habitat previously dominated by gorgonians (octocoral-dominated hardgrounds), suggesting that phase shifts could occur on the order of decades.

Jaap (1998) reports alternating reef strata of *A. cervicornis/prolifera* and head corals visible in reef excavation created by a ship grounding in 1989, suggesting the repeated appearance/loss of staghorn corals over geological time scale in this region. Even over a shorter time scale (1965-2001), photo sequences by Shinn (Fig. 1) show rise and fall of *Acropora* growth in the vicinity of a focal head coral at Grecian Rocks, Key Largo, FKNMS.

Medium-term trends (early 1980s to mid-1990s)

Most published reports of *Acropora* spp. status come from this era (see Table 1, Fig 2). Dustan and Halas (1987) report in a monitoring study at Carysfort a slight increase in coverage by *A. palmata*, but an 18% decrease in coverage of *A. cervicornis* between 1974 and 1982. The *A. palmata* increase was accompanied by a decrease in mean colony size, indicating substantial fragmentation during the study period which the authors attribute largely to anthropogenic physical disturbance (boat groundings and visitor impacts). This suggests that any major white-band disease (WBD) impacts to *A. palmata* at Carysfort Reef probably occurred after 1982. However, the deeper reef terrace at Carysfort Reef, which was historically dominated by staghorn coral, suffered dramatic loss of this species, probably due to disease and predominantly after 1982. Szmant (pers comm) reports a complete loss of both species in the vicinity of the Carysfort tower between summer 1982 and a subsequent visit in April 1984.

Jaap et al. (unpublished) also found stable *A. palmata* populations at Elkhorn reef (Biscayne National Park) from 1977-81 and at Elbow and French reefs (Key Largo) from 1981-86. In contrast, disease and storms caused the demise of *A.cervicornis* at these same reefs. Jaap et al. (1987) reports a monitoring study of Molasses Reef during 1981-86 showing a drastic decline in *A. cervicornis* (96%) over the course of this study, but stable *A. palmata* abundance. Again, this suggests that the major *A. palmata* decline, at least in the Key Largo area took place after 1986. Jaap et al. (unpublished) also observed a complete loss (100%) of 175 colonies of *A. cervicornis* at French reef over the same time period, probably due to storms and/or disease.

Jaap et al. (unpublished) conducted a histological study of coral reproductive activity in Biscayne National Park from September 1977-May 1981. Active gonad development in *A. cervicornis* was observed in all years of the study. However, *A. palmata* failed to display gonad development in 1980.

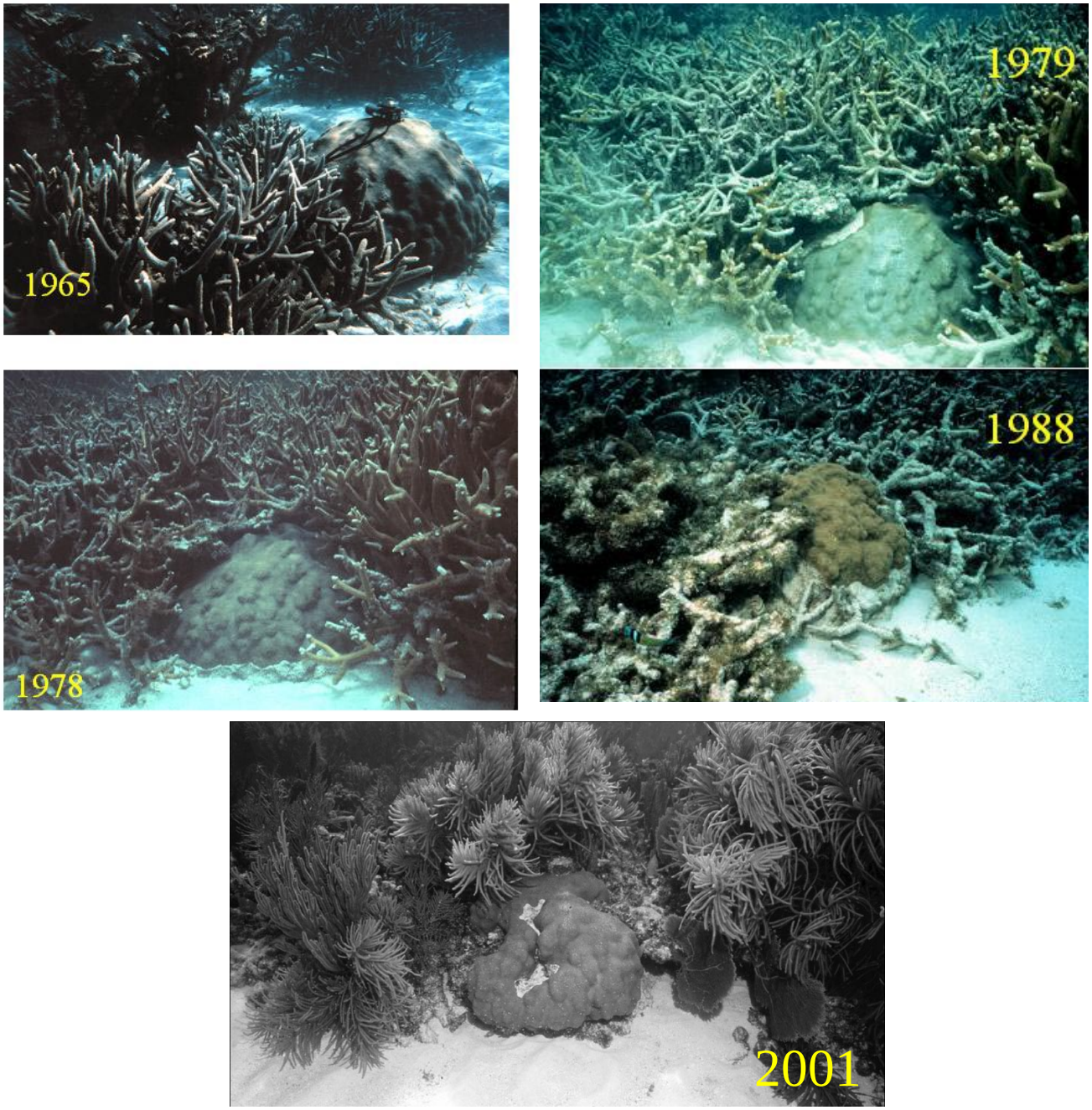

Figure 1. Photo sequence of a single head coral (*Montastraea faveolata*) at Grecian Rocks in the upper Florida Keys National Marine Sanctuary showing increase of *A.cervicornis* following 1965. The thicket was partially dead by 1978 and completely dead but standing by 1979. Between 1979 and 2001, gradual collapse of the thicket structure and colonization by octocorals is observed. Source: EA Shinn

Porter and Meier (1992) report overall loss of *A. palmata* cover (stability at one out of 7 stations) and a substantial decrease in colony size, particularly at Looe Key, over the period of 1984-91. The authors suggested that disease, mortality from bleaching, and algal overgrowth due to reduced urchin grazing were possible factors responsible for the decline.

Fig. 2

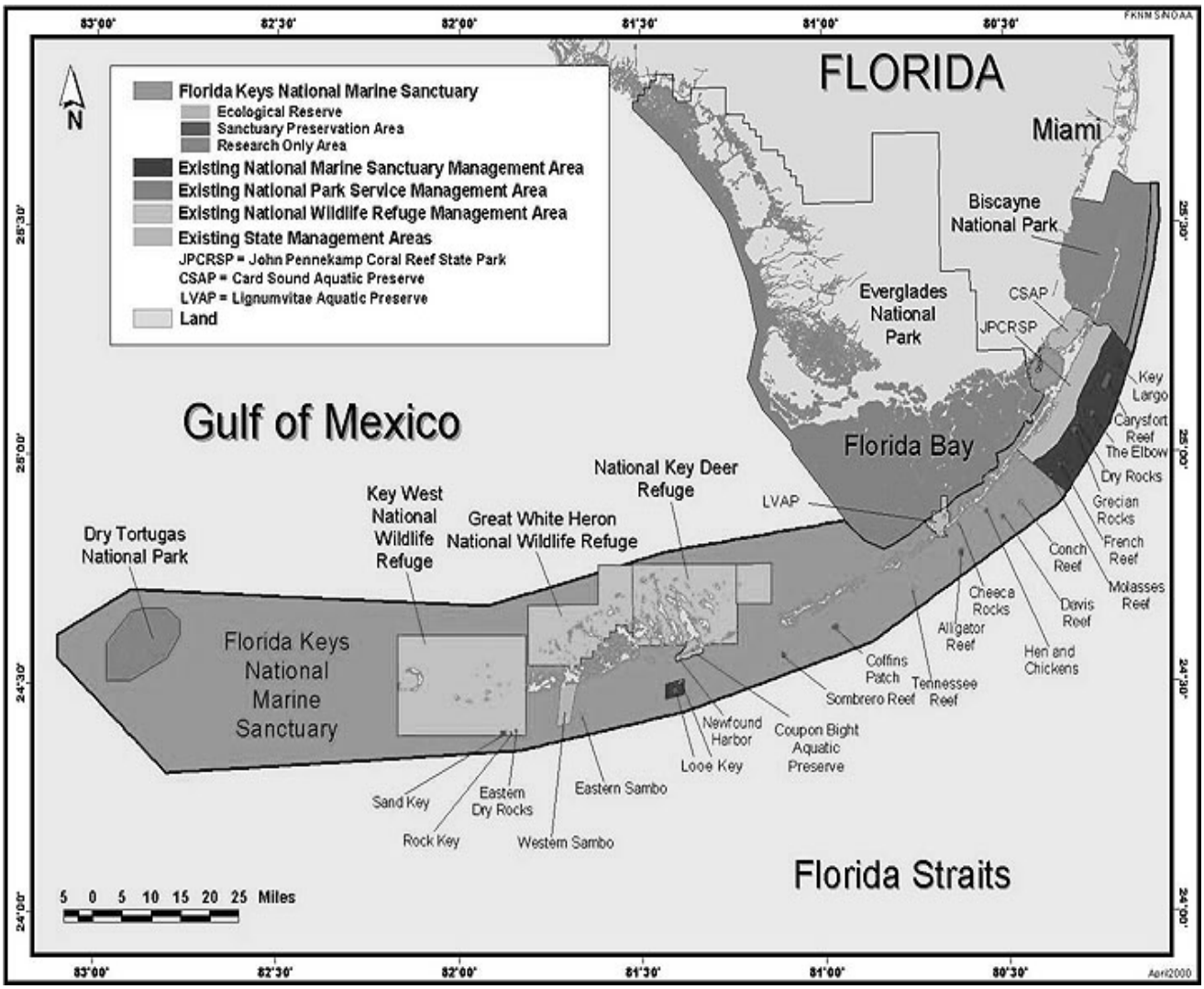

Fig. 2. Map of the region described in this paper. Major sites are numbered from northeast to southwest. Representative sites: 1) Broward County; 2) Ball Buoy, Biscayne National Park; 3) Molasses Reef, FKNMS; 4) Looe Key, FKNMS; 5) Dry Tortugas National Park; 6) Tortugas Bank, FKNMS.

A snapshot mapping study of Looe Key reef suggests areal (m^2) losses of ~93% and ~98% for *A. palmata* and *A. cervicornis*, respectively, between 1983 and 2000 (Miller et al. 2002a). Based on studies by Dustan and Halas (1987) and Jaap et al. (1987), it is quite likely that the 1983 baseline used in this study was already depressed, at least for *A. cervicornis*. A systematic survey of deeper reefs (13-19 m) along the entire Florida Reef Tract in 1995 found *A. cervicornis* to be present at only seven of 20 sites and never at more than 0.62% cover (Aronson and Murdoch, unpublished).

The species status of *Acropora prolifera* is under scrutiny[1], and its history is poorly documented. However, it has suffered population collapse equivalent to *A. cervicornis* and is very rare, being seen in a few locations in Dry Tortugas over the past decade (Jaap, pers. comm.).

[1]Vollmer and Palumbi (2002) present data that demonstrates that *A. prolifera* is a morphologically variable, first generation hybrid of *A. palmata* and *A. cervicornis*.

In summary, available quantitative information indicates that *A. cervicornis* underwent drastic decline in the late 1970s to early 1980s throughout the Florida Keys, although the information with the best temporal resolution comes from the Upper Keys. *A. palmata* decline seems to have been less severe through 1986, reported most commonly as a decline in colony size. *A. palmata* did show severe decline at Looe Key beginning in the late 1980s. There is very little monitoring information available between 1991 and 1996.

Short-term trends (mid-1990s to the present)

Several reef monitoring projects began in the Florida Keys in the mid to -late 1990s (1996 and 1998) which provide excellent quantitative data on coral (including *Acropora*) abundance and, in some cases, condition. Results from these projects are consistent in showing very low colony density and coverage patterns for both species. There is also evidence of *continued* decline in both species over the period from 1996 to 2001. The only exception to this pattern is the discovery of *A.cervicornis* thickets in Broward County, Florida, where monospecific stands appear to be thriving in nearshore hardbottom habitats.

A. Synoptic monitoring of Keys/Tortugas reefs (Chiappone, Swanson, S. Miller):

During 1999-2001, a rapid assessment of 260 sites were sampled in the region, including 204 sites from southwest of Key West to northern Key Largo and 56 sites in Dry Tortugas National Park, the Tortugas Bank, Riley's Hump, and south of the Marquesas Keys in a stratified random sampling scheme. Mean percent coverage for both *Acropora* species, as determined from surveys of 100 points for each of four transects per site, was low. In the Florida Keys, mean coverage by *A. cervicornis* was 0.049% among eight habitat types and did not vary significantly. Mean cover was greatest on high-relief spur and groove reefs (0.049%) and offshore patch reefs (0.045%). Mean coverage by *A. palmata* was even lower throughout the Florida Keys than its congener, even on many high-relief spur and groove reefs where it was formerly abundant. Among the eight habitat types surveyed, *A. palmata* was only recorded in high-relief spur and groove reefs where it was formerly abundant. Mean coverage in this habitat type was 0.158% and ranged from 0.158% in the lower Keys, 0.300% in the middle Keys, to 0.338% in the upper Keys.

The density of *Acropora* colonies was quantified in 25 m x 0.4 m or 10 m x 0.4 m transects. For *A. cervicornis*, mean colony densities among the eight habitat types were no greater than 0.052 colonies/m^2 and there were no significant differences detected in mean colony density among habitat types. Offshore and mid-channel channel patch reefs had the greatest mean densities (0.047-0.052 colonies/m^2). Within strip transect surveys, colonies of *A. palmata* were only found in the high-relief spur and groove habitat. The mean density estimate for this habitat type was 0.036 colonies/m^2, ranging among regions from 0.010/m^2 - 20.010/m^2 in the middle Keys, 0.015/m^2 -20.015/m^2 in the lower Keys, and 0.073/m^2 - 20.073/m^2 in the upper Keys. Patches of numerous colonies were evident at Sand Key, Eastern Dry Rocks, Molasses Reef, Sand Island, and Elbow Reef, most of which are within FKNMS no-fishing zones.

Because density estimates using 25 m x 0.4 m or 10 m x 0.4 m transects were so low for both *Acropora* species, the 2001 surveys also included larger and additional transects to assess densities. For the Florida Keys shallow fore reef, both spur and groove and hardbottom were surveyed from Key West to northern Key Largo at 2 m to 8 m depth. Densities were extremely patchy (Fig. 3) and despite the relatively large sample area, only 43 colonies of *A. cervicornis* and 302 colonies of *A. palmata* were recorded. Maximum

densities for particular reefs were 2.25 colonies/m^2 for *A. cervicornis* and 12.13 colonies/m^2 for *A. palmata* (Fig. 3). In low-relief hard-bottom habitats, 50 *A. cervicornis* and 18 *A. palmata* colonies were encountered and were even more patchily distributed.

The prevalence of disease or disease-like conditions indicated relatively low prevalence of for both *Acropora* species, although few colonies were assessed during 1999-2001. Of the 31 *A. cervicornis* encountered, only one colony exhibited signs of possible recent disease. Three of the 18 colonies of *A. palmata* assessed exhibited either white band disease or signs of recent disease, evidenced by dead white skeleton. Not surprisingly, few juveniles for either *Acropora* species were encountered from the 260 Florida Keys sites. Reconnaissance surveys in several locations, however, did reveal some smaller colonies presumably derived from sexual recruitment, supported by the lack of nearby colonies.

Fig. 3

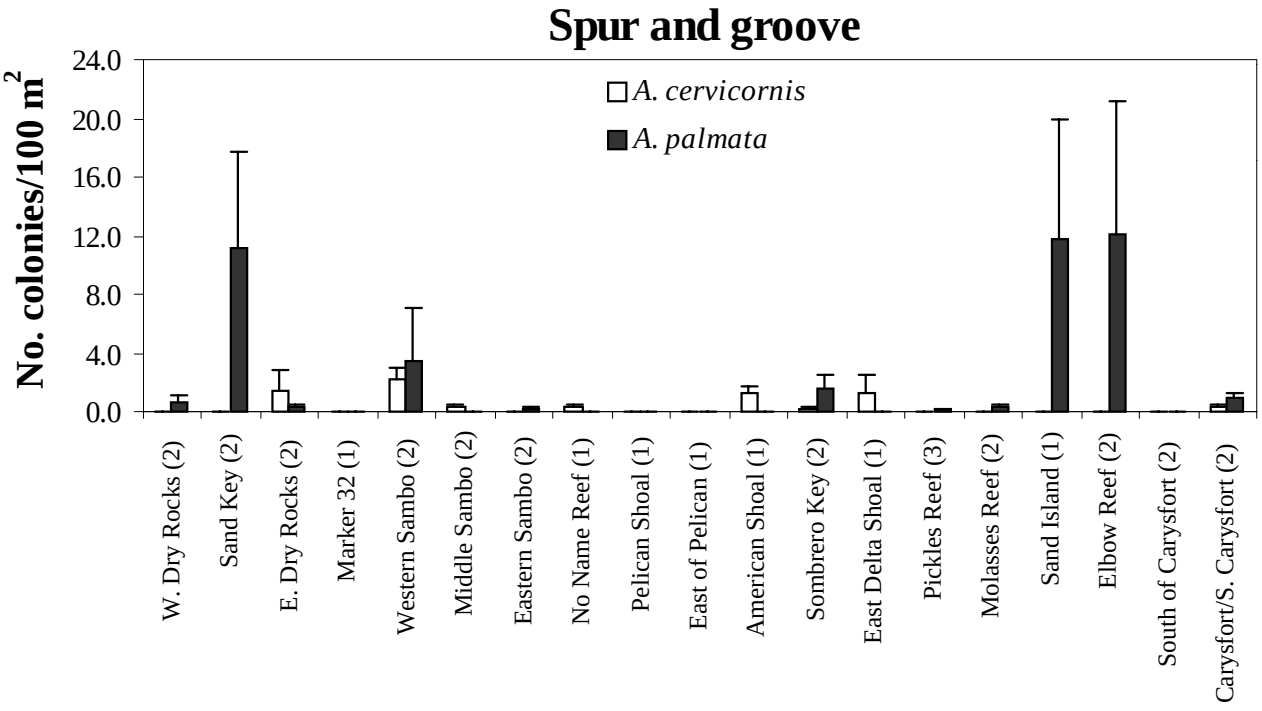

Fig.3. Mean density (no. colonies/100 m^2) of *Acropora cervicornis* and *A. palmata* on high-relief spur and groove reefs on the Florida Keys fore reef during 2001. Sites are arranged from southwest to northeast and error bars represent one standard error. Values in parentheses are the number of sites surveyed for each reef, with 400 m^2 surveyed for colony numbers per site. Source: Chiappone, Swanson, & S.Miller, (unpublished data).

B. Coral Reef Monitoring Program (Coral Reef Monitoring Program, Jaap et al.)

Begun in 1996, the Coral Reef Monitoring Program (CRMP) samples four 10 m permanent video transects at each of over 40 reef sites throughout the Florida Keys and Dry Tortugas. *A. palmata* occurred at five shallow reef sites out of the 40 sampled. The percent cover contributed by *A. palmata* at upper Keys Reefs was low at the beginning of the study (7.2-7.3% in 1996) and declined to less than 1% by 2000. *A. cervicornis* coverage was even lower, declining during 1996 to 2000 from 0.13% in 1996 to 0.03% in the upper Keys, from 0.26% to 0% in the middle Keys, and from 0.11% to 0.02% in the lower Keys. White Shoal, in the Dry Tortugas, is the only site that exhibited relatively stable coverage patterns of *A. cervicornis* (~2-3% cover).

C. Focal monitoring of Acropora palmata (M. Miller, et al.)

A dramatic decline in *A. palmata* abundance was observed at 6 focal patches in the Key Largo area since 1998 (mostly from 1998-1999) and little recovery since then (Miller et al. 2002b). This decline was most evident at sites where *A. palmata* occurs as sparse, individual colonies where total colony abundance fell by 77% between 1998 and 2001. This decline was less evident in denser thicket stands where mean colony density declined from 1.1 colonies/m^2 in 1998 to 0.8 colonies/m^2 in 2001. The incidence of white-band disease in this focal survey study was always less than 6% of colonies for each site and the mean prevalence for all sites was always < 3% of colonies (< 2% in 2001). Prevalence of three-spot damselfish (*Stegastes planifrons*) was much higher, ranging up to 70% of colonies at French Reef in 1998. The mean prevalence (n=6 sites) ranged from 30% to 40% for all survey years. The density of corallivorous gastropods (*Coralliophila abbreviata*) averaged over all surveyed colonies ranged from a mean of ~ 0.5 snails/ colony in 1998 to a maximum over 1 snail/ colony in 2000 and decrease back to ~0.8 in 2001.

D. Broward County Acropora cervicornis (Vargas et al.)

While the geographic range of *A. cervicornis* was always known to extend to Palm Beach County waters, the relatively recent discovery of thriving thickets in Broward County (Fig. 4) was exciting and unexpected, especially given the dismal state of *A. cervicornis* populations in seemingly less marginal areas further south in the Florida Keys. Extensive mapping activities reveal at least six sites with *A. cervicornis* thickets averaging 13% live tissue cover and with *A. cervicornis* colony densities ranging from 1.3-3 colonies/m^2. Recent ecological studies documented linear extension growth rates of 8-9 mm/month and broadcast spawning in this latitudinally marginal population. No occurrence of white-band disease has been observed in these populations.

In contrast, *A. palmata* is extremely rare in Broward County, Florida, and was probably never abundant since the demise of early Holocene reefs (Lighty et al. 1977, 1978 papers discuss the development and demise of the northern Dade to Palm Beach County relict reef system).

Fig. 4

Fig. 4. *Acropora cervicornis* thickets thriving in Broward County, FL. Source: B Vargas-Angel

E. Additional observations

Weaver (personal communication) reports a die-off (13% live cover to <1%) of an *A. cervicornis* thicket at Little Africa reef in the Dry Tortugas between 1995 and 1997. This die-off appears to be from disease, since there is still standing dead structure and a few small colonies/recruits in the surrounding rubble field persist. No recovery was observed at this site between 1997 and 2002.

Current status (May 2002) of *Acropora* spp. in the Dry Tortugas region includes very sparse occurrence of *A. cervicornis* (suffering from damage by threespot damselfish and some disease) on the Tortugas Bank. In 1993, the *A. palmata* patch included an area with high density and peripheral areas with rather low density of *A. palmata*. In May, 2002, the overall status is, *A. palmata* have declined in abundance (qualitative observation) and the higher density cluster is virtually non-existent. A nearby patch of *Acropora prolifera* seems to have expanded noticeably since 1993 and appears healthy and thriving (Jaap, pers. obs.). Interestingly, no corallivorous snails were found on any *Acropora* colonies in the Dry Tortugas in three days of searching in May 2002 (M. Miller pers. obs.).

Current conservation, management and restoration status

The major coral reef management entity in the region is the Florida Keys National Marine Sanctuary (FKNMS), with smaller marine areas administered by the National Park Service and the State of Florida. The FKNMS Management Plan contains 12 separate Action Plans (e.g. zoning, mooring buoys, restoration, channel marking, etc.), all of which contribute to varying degrees to coral protection. While *Acropora* spp. are not explicitly noted in the management plan, they implicitly receive special consideration in all Sanctuary management actions. Additional protective measures to be undertaken could include greater education and outreach effort, improved waterway markers, and harsher penalties, particularly at sites with remnant *A. palmata* populations that receive repeated vessel groundings.

Several management needs persist that could improve management and conservation of *Acropora* spp. populations in the FKNMS. These include more research on *Acropora* recruitment and propagation, distribution and abundance maps for extant *Acropora* populations, and greater capacity for episodic event response.

The FKNMS has undertaken several restoration efforts (and some partnerships with NGOs such as Reef Relief) regarding *Acropora palmata*, particularly in response to groundings in the lower Keys region. Rescue and re-attachment of grounding-generated fragments has had mixed success, in that subsequent storm events have destroyed some of the transplant/nursery structures. Recent research efforts at larval culture and settlement of *A. palmata* have had little success (Szmant and M. Miller, personal observations). Since 1998, two collections at mass-spawn have been accomplished (1998 and 2001 at Horseshoe Reef), but viable larval cultures failed to develop despite similar procedures as had produced successful cultures and settled recruits in past years from spawn collection made at Key Largo Dry Rocks (e.g. 1996). In 2000, no spawning by *A. palmata* was observed either in Key Largo (or in Puerto Rico) over the 3 night window in which spawning was predicted. No observations were made in 1999. One hypothesis is that the *A. palmata* population at Horseshoe reef may not retain sufficient genetic diversity to provide for successful fertilization in the collected cultures. Spawn-collection activities had been shifted to Horseshoe after 1998 when the population abundance at Key Largo Dry Rocks declined to the point of making nighttime spawn collection infeasible. Future efforts will seek to make *A. palmata* spawn collection at multiple sites to increase the likelihood of genetic diversity in the resulting cultures. The intention is to culture the larvae to the point of competence and then expose them to reef substrate to provide for enhanced *A. palmata* settlement/recruitment as a restoration/recovery measure.

Summary

It is clear that dramatic decline in both *A. palmata* and *A. cervicornis* has occurred in Florida over the past two decades and, in the case of *A. palmata* (for which current trend data is available) decline continues through 2001. It appears that noticeable recoveries of both species have occurred in the historical past in the Dry Tortugas region where the observational time line is over a century. Juveniles of both species are observed at a range of locations, but it is unclear whether they represent a trajectory of population increase as their fate is unclear. Current observations of disease incidence are low (~2-3% of colonies) but somewhat patchy in distribution. Active predation (by snails and fire worms) is observed on 10-30% of colonies in well-studied areas and is the most obvious chronic (and potentially manageable) threat. Little quantitative population benefit from restoration efforts to date has been documented.

Table 1: Site-specific condition of *Acropora palmata* in Florida. Sites are arranged from northeast to southwest and approximate location can be interpolated from the map in Fig. 2. po = personal observation; SP= snail prevalence (i.e. proportion of colonies infested by *Coralliophila abbreviata*); WBD=White-band disease, presence/absence or proportion of infected colonies; CRMP = Coral Reef Monitoring Project (Jaap et al.); other published sources listed in references. On opposite page.

Table 1. Site-specific condition of *Acropora palmata* in Florida.

Site	Trend	Time-frame	Current status	Extent of decline	Condition in 2001 (Predators,WBD)	Reproduction /recruitment?	Source
Elkhorn	Decline	70's-01	Rare	Very High	Snails present	Recruits ~20cm (cohort?) present	Jaap, Curry/M.Miller (po)
Elkhorn Control	Decline	1970's-2001					Jaap (po)
Ball Buoy	Decline	1970's-2001	Rare				Jaap. Curry (po)
Carysfort	Stable	1974-1982					Dustan&Halas1987
	Collapse	1982-84		Very high			Szmant po
	Decline	96-01					CRMP
South Carysfort	Decline	98-01	0.27 col m^{-2} in thicket	65% (density)	SP=0.25; 0.6 snail $colony^{-1}$		
Grecian	Decline	96-01					CRMP
Little Grecian	Stable	98-01	Decent Thicket (2)		SP=0.33; 1.1 snail $colony^{-1}$		M. Miller et al
KL Dry Rocks	Decline	70's-01	<20 colonies	Very High	Snails high; Some sexual recruits (2001) but with serious snail infestation		Jaap po M. Miller, po
Elbow	Decline	70's-01	~0.1 col m^{-2}				Jaap (po), Chiappone et al.
Horseshoe	Stable	98-01	Decent Thicket	Slight	SP=0.14; 0.3 snail $colony^{-1}$	Spawning observed in 2001, not 2000	M. Miller (2002b)
Sand Island	?	00-02	~0.1 col m^{-2}		WBD, heavy snail impact		Szmant (po), Chiappone et al.
French	Decline	98-01	<50 colonies	80% (# colonies)	SP=0.38; 1.1 snail $colony^{-1}$		M. Miller (2002b)
Molasses	Stable	81-86					Jaap et al
	Decline	96-01					CRMP
	Decline	98-01	Sparse colonies	76% (# colonies	SP=0.33; 0.93 snail $colony^{-1}$		M. Miller (2002b)
Pickles	Decline	96-01	<20 colonies	68% (# colonies)	SP=0.26; 0.83 snail $colony^{-1}$		M. Miller (2002b)
Sombrero	Decline	96-01	Virtually gone				CRMP
Looe	Decline	96-01					CRMP
		83-00		93% areal coverage	Snails present	Some small recruits	M. Miller et al. 2002a
Eastern Sambo	Decline	96-01					CRMP
Western Sambo	Decline	96-01	Decent Thicket				po
Middle Sambo	Decline	70's-01	11 colonies (2001)				M. Miller (po)
Rock Key	Decline	96-01					CRMP
Sand Key	Decline	96-01	~0.1 col m^{-2}				CRMP; Chiappone et al.
Eastern DR	Decline	70's					
Western DR	Decline	70's					
Dry	Stable	93-02	~600m2		No snails present, high		Jaap, M. Miller

Table 2. Site-specific information on *Acropora cervicornis* in south Florida. Sites are arranged from southwest to northeast and approximate location can be interpolated from the map in Fig. 2.
****Observation relates to Acropora prolifera*

Site	Trend	Time-frame	Current status	Extent of decline	Condition in 2001 (Predators,WBD)	Reproduction /recruitment?	Source
Little Africa, DT	Decline	95-01	~Absent	~100% from 95-97		-	Weaver (po)
****5-ft Channel, DT* ***A.prolifera***	*Increase*	*93-02*	*Large thicket*		*No snails, some colonies look pale*		*Jaap, MMiller (po)*
Tortugas Bank	?	96?	<1% live cover				Aronson, Keys Wide Cruise
Tortugas Bank	?	02	Scattered colonies	?	No snails, some WBD, some damselfish damage	Few sexual recruits observed	M. Miller (po)
White Shoal, DT			Scattered colonies				Jaap
Pulaski Shoal, DT	?	96?	<0.5% cover				Aronson, Keys Wide Cruise
28 ft. Shoal	?	96?	<0.5% cover				Aronson, Keys Wide Cruise
West Sambo	?	96?	<1% cover				Aronson, Keys Wide Cruise
Looe Key	Collapse	83-00		98% of areal cover	Snails present		Miller et al. (in press)
	?	96?	<0.5% cover				Aronson, Keys-wide cruise
No Name	?	96?	<0.5% cover				Aronson, Keys-wide cruise
Pickles	?	96?	<0.5% cover				Aronson, Keys-wide cruise
Molasses	Collapse	1981-86		96%			Jaap et al. (1987)
French	Collapse	1981-86		100%			Jaap et al. unpub.
Carysfort	Decline	1974-82		18%			Dustan and Halas (1987)
Broward County	Increase	1996-2002	13% cover		predators present	Spawning in 2001	Vargas-Angel et al.

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